

This is in response to the Amendment dated November 28, 2011. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office Action.

The finality of the rejection of the last Office action is withdrawn in view of the new grounds of rejection.

Response to Arguments

Claim Rejections - 35 USC § 112

I. Claims **1-27** have been rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

The rejection of claims 1-27 under 35 U.S.C. 112, second paragraph, has been withdrawn in view of Applicants' amendment.

II. Claims **1-27** are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. The omitted structural cooperative relationships are: between steps (a) and (b).

The rejection of claims 1-27 under 35 U.S.C. 112, second paragraph, has been

withdrawn in view of Applicants' amendment.

III. Claim 4 has been rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. The omitted structural cooperative relationships are: between step (a) in claim 1 and step (a) in claim 4.

The rejection of claim 4 under 35 U.S.C. 112, second paragraph, has been withdrawn in view of Applicants' amendment.

Allowable Subject Matter

The indicated allowability of claims 1-27 is withdrawn in view of the newly discovered reference(s) to **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37), **Scurto et al.** ("Carbon Dioxide Induced Separation of Ionic Liquids and Water", *Chem. Commun.* (2003), pp. 572-573), **JP 6-154554** ('554), **Blais et al.** (US Patent No. 6,524,843 B1) and **Gentzis** ("Subsurface Sequestration of Carbon Dioxide - An Overview from an Alberta (Canada) Perspective", *International Journal of Coal Geology* (2000), Vol. 43, pp. 287-305). Rejections based on the newly cited reference(s) follow.

Response to Amendment

Claim Rejections - 35 USC § 112

I. Claims 1-27 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1

lines 7-9, recite "with the provision that in (iii) and (iv) resultant absorbed CO₂ in an aqueous phase is transferred to a water-insoluble ionic liquid medium."

It appears that the aqueous phase is the same as the aqueous phase recited in claim 1, lines 5-6. However, the claim language is unclear as to whether it is. The subsequent mention of an element is to be modified by the definite article "the", "said" or "the said," thereby making the latter mention(s) of the element unequivocally referable to its earlier recitation.

line 10, recites "resultant pressurized CO₂ from step (i)". If CO₂ is liquefied in step (i) [see claim 1, lines 3-4], wouldn't the result be liquefied CO₂? Or is the resultant pressurized CO₂ the same as the liquefied CO₂?

line 10, it appears that the "liquid" is the same as the polar aprotic liquid recited in claim 1, line 4. However, the claim language is unclear as to whether it is.

lines 10-11, recite "liquid or resultant absorbed CO₂, in said aprotic medium

from step (ii).” Claim 1, lines 4-5, recite “(ii) absorbing CO₂ in a polar aprotic liquid, not miscible with water, or miscible with water in various proportions.” If CO₂ is absorbed in the polar aprotic liquid, then how can it be one or the other, i.e., liquid or resultant absorbed CO₂ that is electro-reduced?

line 11, “said aprotic medium” lacks antecedent basis.

lines 12-13, it appears that “a water-insoluble ionic medium” is the same as the water-insoluble ionic liquid medium recited in claim 1, lines 8-9. However, it is unclear from the claim language as to whether it is. The subsequent mention of an element is to be modified by the definite article “the”, “said” or “the said,” thereby making the latter mention(s) of the element unequivocally referable to its earlier recitation.

Claim 4

line 2, recites “said absorbing of CO₂.” It is unclear from the claim language which step this is further limiting in claim 1, lines 4-7. Is it the absorbing CO₂ from (ii), (iii) or (iv)?

Claim 9

lines 1-2, “the resultant liquid phase” lacks antecedent basis.

Claim 11

lines 1-2, "the resultant aqueous solution" lacks antecedent basis.

Claim 17

lines 1-2, "the oxalic acid or oxalate, obtained in the aprotic medium" lacks antecedent basis.

Claim 20

lines 2-3, it appears that "an aqueous solution of oxalic acid or formic acid" is the same as the oxalic acid or formic acid in an aqueous phase as recited in claim 1, lines 15-16. However, the claim language is unclear as to whether it is.

Claim 23

lines 1-3, it appears that "in which the mineralization step comprises bringing an aqueous solution of oxalic acid or formic acid derived from the extracting step into contact with a calciferous or magnesia-containing sedimentary rock" is further limiting the step for mineralization by reacting said oxalic acid or formic acid with a carbonate of an element M, producing a mineral recited in claim 1, lines 17-20. However, the claim language is unclear as to whether it is.

Since the process recited in present claim 1 already requires mineralization by reacting said oxalic acid or formic acid with a carbonate of an element M, producing a

mineral, then the subsequent mention of the mineralization step in claim 23 has to be -- further comprises -- limiting. But that doesn't make sense if the oxalic acid or formic acid both reacts or contacts with a carbonate and a calciferous or magnesia-containing sedimentary rock to produce the mineral?

Claim 27

line 1, "said carbonated mineral" lacks antecedent basis. Claim 1, line 18, recites "producing a mineral".

II. Claims **1-27** are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. The omitted structural cooperative relationships are: between the aqueous solution and the solvent.

Claim 1

lines 6-7, recite "(iv) absorbing CO₂ in the hydrated form in a solvent, activated by an enzymatic pathway."

lines 7-9, recite "with the provision that in (iii) and (iv) resultant absorbed CO₂ in an aqueous phase is transferred to a water-insoluble ionic liquid medium."

If absorbed CO₂ in an aqueous phase results from (iv), then is the solvent the CO₂ is absorbed in also aqueous? The claim language is unclear as to whether it is.

III. Claims **9 and 10** are rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. The omitted structural cooperative relationships are: between the resultant liquid phase and the liquid phase containing concentrated CO₂.

Claim 1

line 2, recites "a step for concentration CO₂ in a liquid phase."

Claim 9

lines 1-2, recite "the resultant liquid phase obtained."

The claim language is unclear as to the relationship between the liquid phase containing concentrated CO₂ and the resultant liquid phase, and whether or not the liquid phase containing concentrated CO₂ is the same as the resultant liquid phase.

IV. Claim **23** is rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See

MPEP § 2172.01. The omitted structural cooperative relationships are: bringing an aqueous solution of oxalic acid or formic acid derived from the extracting step into contact with a calciferous or magnesia-containing sedimentary rock and reacting said oxalic acid or formic acid with a carbonate of an element M, producing a mineral.

Claim 1

lines 17-20, recite "a step for mineralization by reacting said oxalic acid or formic acid with a carbonate of an element M, producing a mineral in which the atomic ratio C/M is about 2/1, wherein M is any metallic element with an oxidation number of +2, and C is carbon, and wherein the oxalic acid and formic acid are in an acid or salt form."

Claim 23

lines 1-3, recite "in which the mineralization step comprises bringing an aqueous solution of oxalic acid or formic acid derived from the extracting step into contact with a calciferous or magnesia-containing sedimentary rock."

It is unclear from the claim language how the mineral is produced. The oxalic acid or formic acid contacts two different materials, i.e., a carbonate of an element M and a calciferous or magnesia-containing sedimentary rock.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

I. Claims 1-3, 12-16, 20 and 22-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37).

Abbott teaches a process for sequestering carbon emitted into the atmosphere, characterized in that it comprises:

a) a step for concentrating CO₂ in a liquid phase, said step comprising any of the following: (i) liquefying CO₂ in a liquid phase under pressure up to the supercritical state; (ii) absorbing CO₂ in a polar aprotic liquid, not miscible with water, or miscible with water in various proportions; (iii) absorbing CO₂ in an aqueous phase containing an alcohol and/or an amine; (iv) absorbing CO₂ in the hydrated form in a solvent, activated by an enzymatic pathway, with the provision that in (iii) and (iv) resultant absorbed CO₂ in an aqueous phase is transferred to a water-insoluble ionic liquid medium (= the concentration of CO₂ in solution can be raised by increasing the CO₂ pressure) [page 775, right column, lines 40-42];

b) a step for electro-reduction of resultant pressurized CO_2 from step (i) [= the electroreduction of CO_2 at Pt and Pb electrodes in supercritical CO_2 /HFC 134a solvent mixtures] [page 776, left column, lines 54-56] liquid or resultant absorbed CO_2 , in said aprotic medium from step (ii) or resultant CO_2 from step (iii) or step (iv) transferred to a water-insoluble ionic medium to oxalic acid or formic acid in which the carbon changes to oxidation number +3 (= oxalic acid) [page 778, Table 1]; and

c) if appropriate, a step for extracting said oxalic acid or formic acid in an aqueous phase,

and wherein the oxalic acid and formic acid are in an acid or salt form (= oxalic acid) [page 778, Table 1].

Step a) for concentration in the liquid phase comprises the liquefying CO_2 of said CO_2 , the liquid CO_2 then being obtained under the said pressure, up to the supercritical state (= the concentration of CO_2 in solution can be raised by increasing the CO_2 pressure) [page 775, right column, lines 40-42].

Step a) for concentration in the liquid phase comprises the absorbing of the CO_2 in the polar aprotic liquid (= HFC 134a is aprotic), not miscible with the water or miscible with the water in various proportions (page 776, left column, lines 49-50 and 54-57).

The anode used in the electro-reduction step is constituted by platinum, diamond-doped with boron or carbon doped with nitrogen (= the outer stainless steel cylinder formed the anode and was platinized by standard technique) [page 776, right column, lines 22-23].

The electro-reduction step b) is carried out in liquid CO₂ under pressure (= the electroreduction of CO₂ at Pt and Pb electrodes in supercritical CO₂/HFC 134a solvent mixtures) [page 776, left column, lines 54-56].

A compound from electro-reduction step b) is comprises oxalic acid or an oxalate (= oxalic acid) [page 778, Table 1].

The process of Abbott differs from the instant invention because Abbott does not disclose the following:

a. A step for mineralization by reacting said oxalic acid or formic acid with a carbonate of an element M, producing a mineral in which the atomic ratio C/M is about 2/1, wherein M is any metallic element with an oxidation number of +2, and C is carbon, as recited in claim **1**.

b. In which the element M is calcium and the mineral formed is Whewellite, CaC₂O₄·H₂O, as recited in claim **22**.

c. In which the mineralization step comprises bringing an aqueous solution of oxalic acid or formic acid derived from the extracting step into contact with a calciferous or magnesia-containing sedimentary rock, as recited in claim **23**.

Abbott teaches oxalic acid as an electrochemical reduction product of CO₂ (page 778, Table 1).

Sabbioni teaches that oxalic acid attacks the calcium carbonate of the stone giving rise to the precipitation of calcium oxalate (page 31, "Summary"; and page 34,

"Discussion").

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the method described by Abbott with (a) to (c) above because reacting oxalic acid with limestone (calcium carbonate) would have formed Whewellite (calcium oxalate) as taught by Sabbioni (page 31, "Summary"; and page 34, "Discussion").

d. In which the electro-reduction step b) is carried out at a pH in the range of 3 to 10 and with an anode maintained at a potential of +0.5 to -3.5 volts with respect to the normal hydrogen electrode, as recited in claim **12**.

e. In which the pH is in the range of 3 to 7, as recited in claim **13**.

Abbott teaches 30.6 mol% 1,1,1,2-tetrafluoroethane (HFC 134a) in CO₂ mixture (ICI Klea group, 99.99%) and the electrolyte, tetrabutylammonium tetrafluoroborate (Fluka, electrochemical grade) [page 776, right column, lines 29-32]. The mixture disclosed by Abbott naturally has a pH, and it would have been either acidic, neutral or basic.

It has been held that changes in temperature, concentration or both, is not a patentable modification; however, such changes may impart patentability to a process if the ranges claimed produce new and unexpected results which are different in kind and not merely in degree from results of the prior art, such ranges are termed "critical" ranges and Applicant has the burden of proving such criticality; even though Applicant's

modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within capabilities of one skilled in the art; more particularly, where general conditions of the claim are disclosed in the prior art, it is not inventive to discover optimum or workable ranges by routine experimentation. *In re Aller*, 220 F2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) [MPEP § 2144.05].

Abbott teaches an anode potential (page 776, Fig. 1: see the three leads coming out from the potentiostat). It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the anode potential described by Abbott with an anode maintained at a potential of +0.5 to -3.5 volts with respect to the normal hydrogen electrode because the anode potential is a result-effective variable and one having ordinary skill in the art has the skill to calculate the anode potential that would have determined the success of the desired reaction to occur (MPEP § 2141.03 and § 2144.05).

f. Wherein incorporating step (c) in which a final mineralization step comprises an attack of a carbonated mineral by an aqueous solution of oxalic acid or formic acid from the extracting step (c), as recited in claims **20 and 26**.

Sabbioni teaches that oxalic acid attacks the calcium carbonate of the stone giving rise to the precipitation of calcium oxalate (page 31, "Summary"; and page 34, "Discussion").

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified step (c) described by the Abbott combination by

incorporating step (c) in which a final mineralization step comprises an attack of a carbonated mineral by an aqueous solution of oxalic acid or formic acid from the extracting step (c) because the repetition of steps to provide the same results is within the skill of one having ordinary skill in the art. The concept of duplication is not patentable. *St. Regis Paper Co. v. Bemis Co. Inc.*, 193 USPQ 8, 11 (7th Cir. 1977). While this decision relates to the duplication of parts, there is no reason why such duplication cannot be extended to a process step.

g. In which a final mineralization step comprises injection into a substratum, as recited in claim **24**.

Sabbioni teaches that from a mineralogical point of view, these patinas are formed of a mixture of calcium oxalates (page 32, right column, lines 28-34).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified final mineralization step described by the Abbott combination with wherein in which a final mineralization step comprises injection into a substratum because this would have formed a patina as taught by Sabbioni (page 32, right column, lines 28-34).

h. In which said carbonated mineral comprises a calciferous or magnesia-containing carbonated mineral, as recited in claim **27**.

Sabbioni teaches that oxalic acid attacks the calcium carbonate of the stone

giving rise to the precipitation of calcium oxalate (page 31, "Summary"; and page 34, "Discussion").

II. Claims **4 and 5** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **Scurto et al.** ("Carbon Dioxide Induced Separation of Ionic Liquids and Water", *Chem. Commun.* (2003), pp. 572-573).

Abbott and Sabbioni are as applied above and incorporated.

The process of Abbott differs from the instant invention because Abbott does not disclose the following:

- a. Wherein said step a) for concentrating CO₂ in the liquid phase comprises said absorbing of CO₂ in an aprotic ionic liquid, as recited in claim **4**.
- b. Wherein said ionic liquid comprises 1-butyl-3-methylimidazolium hexafluorophosphate, as recited in claim **5**.

Scurto teaches that mixtures of water and hydrophobic IL, 1-butyl-3-methylimidazolium hexafluorophosphate ([C₄mim][PF₆]), is shown to phase split in the presence of gaseous CO₂ (page 572, lower left column; and Fig. 1).

It would have been obvious to one having ordinary skill in the art at the time the

invention was made to have modified step a) described by Abbott with wherein (a) and (b) above because mixtures of water and hydrophobic IL, 1-butyl-3-methylimidazolium hexafluorophosphate ([C₄mim][PF₆]) would have phase split in the presence of gaseous CO₂ as taught by Scruto (page 572, lower left column; and Fig. 1).

III. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **JP 6-154554** ('554).

Abbott and Sabbioni are as applied above and incorporated.

The process of Abbott differs from the instant invention because Abbott does not disclose wherein in that step a) for concentration in the liquid phase comprises the absorbing of the CO₂ in the aqueous phase containing the alcohol and/or the amine, as recited in claim 6.

JP '554 teaches the steps of removing CO₂ in a gas by bringing an aqueous solution of an amine compound (e.g., monoethanolamine) in contact with the gas as a CO₂ absorption liquid, and isolating CO₂ from the absorption liquid which has absorbed CO₂ in an absorption liquid regeneration tower (abstracts).

It would have been obvious to one having ordinary skill in the art at the time the

invention was made to have modified step a) described by Abbott with wherein in that step a) for concentration in the liquid phase comprises the absorbing of the CO₂ in the aqueous phase containing the alcohol and/or the amine because bringing an aqueous solution of an amine compound (e.g., monoethanolamine) in contact with the gas as a CO₂ absorption liquid would have removed CO₂ as taught by JP '554 (abstracts).

IV. Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **JP 6-154554** ('554) as applied to claim 6 above, and further in view of **Scurto et al.** ("Carbon Dioxide Induced Separation of Ionic Liquids and Water", *Chem. Commun.* (2003), pp. 572-573).

Abbott and Sabbioni are as applied above and incorporated.

The process of Abbott differs from the instant invention because Abbott does not disclose wherein the resultant aqueous solution obtained is transferred by a liquid-liquid extraction process to an ionic liquid medium which is insoluble in water, as recited in claim 11.

Scurto teaches that mixtures of water and hydrophobic IL, 1-butyl-3-methylimidazolium hexafluorophosphate ([C₄mim][PF₆]), is shown to phase split in the presence of gaseous CO₂ (page 572, lower left column; and Fig. 1).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the resultant aqueous solution obtained described by the Abbott combination with wherein the resultant aqueous solution obtained is transferred by a liquid-liquid extraction process to an ionic liquid medium which is insoluble in water because mixtures of water and hydrophobic IL, 1-butyl-3-methylimidazolium hexafluorophosphate ($[\text{C}_4\text{mim}][\text{PF}_6]$) would have phase split in the presence of gaseous CO_2 as taught by Scruto (page 572, lower left column; and Fig. 1).

V. Claims **7 and 8** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO_2 in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **Blais et al.** (US Patent No. 6,524,843 B1).

Abbott and Sabbioni are as applied above and incorporated.

The process of Abbott differs from the instant invention because Abbott does not disclose the following:

- a. Wherein in that step a) for concentration in the liquid phase comprises the absorbing of the CO_2 in the hydrated form being activated by the enzymatic pathway, as recited in claim 7.
- b. Wherein the hydration activating enzyme comprises carbonic anhydrase,

as recited in claim 8.

Blais teaches that:

The present invention is also directed to a process for removing CO₂ from a CO₂-containing gas, characterized in that it comprises the step of: a) contacting the CO₂-containing gas with an aqueous liquid, preferably water, in a bioreactor containing immobilized carbonic anhydrase, or an analog thereof, the carbonic anhydrase catalysing the hydration of the CO₂ into hydrogen ions and bicarbonate ions (col. 3, lines 6-13).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified step a) described by Abbott with (a) and (b) above because contacting a CO₂-containing gas with an aqueous liquid, preferably water, in a bioreactor containing immobilized carbonic anhydrase, would have catalyzed the hydration of the CO₂ into hydrogen ions and bicarbonate ions as taught by Blais (col. 3, lines 6-13).

VI. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **Blais et al.** (US Patent No. 6,524,843 B1) as applied to claims 7 and 8 above, and further in view of **JP 6-154554** ('554).

Abbott and Sabbioni are as applied above and incorporated.

The process of Abbott differs from the instant invention because Abbott does not

disclose the following:

a. Wherein the resultant liquid phase obtained is then recycled to a process for absorption of CO₂ in an aqueous phase in the presence of an alcohol and/or amine, as recited in claim **9**.

JP '554 teaches the steps of removing CO₂ in a gas by bringing an aqueous solution of an amine compound (e.g., monoethanolamine) in contact with the gas as a CO₂ absorption liquid, and isolating CO₂ from the absorption liquid which has absorbed CO₂ in an absorption liquid regeneration tower (abstracts).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified step a) described by the Abbott combination with wherein in that step a) for concentration in the liquid phase comprises the absorbing of the CO₂ in the aqueous phase containing the alcohol and/or the amine because bringing an aqueous solution of an amine compound (e.g., monoethanolamine) in contact with the gas as a CO₂ absorption liquid would have removed CO₂ as taught by JP '554 (abstracts).

b. Wherein the aqueous phase obtained is recycled to a liquefaction process of CO₂ under pressure, as recited in claim **10**.

Abbott teaches the concentration of CO₂ in solution can be raised by increasing the CO₂ pressure (page 775, right column, lines 40-42).

It would have been obvious to one having ordinary skill in the art at the time the

invention was made to have modified the aqueous phase obtained as described by the Abbott combination with wherein the aqueous phase obtained is recycled to a liquefaction process of CO₂ under pressure because increasing the CO₂ pressure would have concentrated CO₂ in solution as taught by Abbott (page 775, right column, lines 40-42).

VII. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **Baniel et al.** (US Patent No. 4,275,234).

Abbott and Sabbioni are as applied above and incorporated herein.

The process of Abbott differs from the instant invention because Abbott does not disclose in which the oxalic acid or oxalate, obtained in a non-aqueous medium, is re-extracted by an aqueous phase, as recited in claim 17.

Baniel teaches the recovery of acids from aqueous solutions. Baniel teaches:

100 g of a 2% w/w aqueous solution of oxalic acid was extracted in a separatory funnel with 35 g of an extractant containing 25% w/w dilaurylbenzylamine, 69% w/w of n-octane and 6% w/w of 1-n-octanol. After shaking at 40°C and phase separation, the aqueous raffinate was substantially free of oxalic acid. The extract contained 5.4% w/w of oxalic acid.

The extract was separated, diluted with a further 50 g of n-octane and heated to 80°C, and back-extracted with 30 g water heated to the same temperature. The oxalic acid was back-extracted almost completely. The organic extractant phase contained less

than about 0.5% w/w oxalic acid (col. 9, Example 16).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the oxalic acid or oxalate described by Abbott with wherein the oxalic acid or oxalate, obtained in a non-aqueous medium, is re-extracted by an aqueous phase because back-extracting a non-aqueous phase with water would have been conventional in the recovery of an acid from an aqueous solution as taught by Baniel (col. 9, Example 16).

VIII. Claims **18-19 and 21** are rejected under 35 U.S.C. 103(a) as being unpatentable over **Abbott et al.** ("Electrochemical Reduction of CO₂ in a Mixed Supercritical Fluid", *J. Phys. Chem B* (2000), Vol. 104, pp. 775-779) in view of **Sabbioni et al.** ("Oxalate Patinas on Ancient Monuments: The Biological Hypothesis", *Aerobiologia* (1991), Vol. 7, pp. 31-37) as applied to claims 1-3, 12-16, 20 and 22-27 above, and further in view of **Gentzis** ("Subsurface Sequestration of Carbon Dioxide - An Overview from an Alberta (Canada) Perspective", *International Journal of Coal Geology* (2000), Vol. 43, pp. 287-305).

Abbott and Sabbioni are as applied above and incorporated.

The process of Abbott differs from the instant invention because Abbott does not disclose the following:

a. In which, at the end of step a), liquid CO₂ is injected into a subterranean CO₂ store, as recited in claim **18**.

Gentzis teaches sequestration of CO₂ in depleted oil and gas reservoirs (pages 295-296, "4.5. Sequestration of CO₂ in depleted oil and gas reservoirs").

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the process described by Abbott with in which, at the end of step a), liquid CO₂ is injected into a subterranean CO₂ store because CO₂ disposal in depleted oil and gas reservoirs would have sequestered CO₂ in the underground volume that was occupied by hydrocarbons produced from the reservoirs as taught by Gentzis (pages 295-296, "4.5. Sequestration of CO₂ in depleted oil and gas reservoirs").

b. In which electro-reduction step b) is carried out in the subterranean CO₂ store, as recited in claim **19**.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the electro-reduction step b) described by Abbott with in which electro-reduction step b) is carried out in the subterranean CO₂ store because the selection of old parts to operate in new environments in order to achieve the same results was held to have been obvious. *In re Ross* 105 USPQ 237. And the substitution of known equivalent structures was held to have been obvious. *In re Ruff* 118 USPQ 343 (CCPA 1958).

c. In which said mineral comprises a calciferous or magnesia-containing

carbonated mineral, as recited in claim **21**.

Sabbioni teaches that oxalic acid attacks the calcium carbonate of the stone giving rise to the precipitation of calcium oxalate (page 31, "Summary"; and page 34, "Discussion").

Citations

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ang et al. (US Patent No. 4,673,473) is cited to teach reducing carbon dioxide to a product.

Edwards et al. ("FT-Raman Spectroscopy of Lichens on Dolomitic Rocks: An Assessment of Metal Oxalate Formation", *Analyst* (2003), Vol. 128, pp. 1218-1221) is cited to teach that the lichen specimens were provided still attached to their substrata. which was dolomite formulated as $\text{CaMg}(\text{CO}_3)_2$, or a magnesium-rich carbonaceous variant in which the calcium to magnesium ratio is >1 . Hence, each lichen is presented with the possibility of attacking the Ca or Mg compounds of the carbonaceous rock (page 1219, left column, "Specimens").

Any inquiry concerning this communication or earlier communications from the examiner should be directed to EDNA WONG whose telephone number is (571)272-1349. The examiner can normally be reached on Mon-Fri 7:30 am to 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jeffrey T. Barton can be reached on (571) 272-1307. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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